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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF PLANT INDUSTRY—Circular No. 132.
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MISCELLANEOUS PAPERS.

The Farmer's Income . . . . . W. J. SPILLMAN
Cotton Farming in the Southwest . . . . . O. F. COOK
Mosaic Coherence of Characters in Seeds of Maize . . . . . G. N. COLLINS

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[Cir. 132]

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THE FARMER'S INCOME.[1]

By W. J. Spillman, *Agriculturist in Charge of the Office of Farm Management.*

INTRODUCTION.

It has never been possible to secure accurate data on the average income of American farmers. It happens, however, that the data collected in the census of 1910, combined with certain factors worked out in the experience of the Office of Farm Management in conducting farm-management surveys, render it possible to arrive at a sum which, if increased by two small unknown items and decreased by one rather large but unknown item, would represent the farmer's net income. The two additions probably do not balance the one deduction, so that the actual net income is almost certainly less than the sum given in Table I.

Table I.—*Labor income of farmers in the United States.*

Page.[2]	Item.		Total.	Amount per farm.
268	Number of farms		6,361,502	138.1 acres.[3]
269	Improved land.....acres..		478,451,750	75.2 acres.
276	Total farm investment		$40,991,449,090	$6,443.67.
277	Investment in farm buildings		$6,325,451 528	$994.33.
277	Investment in implements and machinery		$1,265,149,783	$198.88.
	Receipts.			
348	Dairy products (excluding milk and cream used at home)		$596,413,463	$93.75
352	Wool		65,472,328	10.29
352	Mohair		901,597	.14
355	Eggs produced		306,688,960	48.21
355	Poultry raised		202,506,272	31.83
356	Honey and wax		5,992,083	.94
358	Domestic animals sold		1,562,936,694	245.69
358	Domestic animals slaughtered		270,238,793	42.48
370	Total value of all crops	$5,487,161,223		
379	Corn	$1,438,553,919		
383	Oats	414,697,422		
388	Barley	92,458,571		
397	Hay, etc	824,004,877		
	Total value of crops used for feeding	2,769,714,789		
373	Feed sold	509,253,522		
	Net value of crops fed	2,260,461,267		
	Net value of crops		3,226,699,956	507.22
	Total gross farm income		6,237,850,146	980.55

[1] Issued July 19, 1913. [2] Abstract of the Thirteenth Census. [3] Average total area per farm.

TABLE I.—*Labor income of farmers in the United States*—Continued.

EXPENSES.

Page.	Item.	Total.	Amount per farm.
373	Labor	$651,611,287	$102.43
373	Fertilizers	114,882,541	18.06
373	Feed	299,839,857	47.13
	Maintenance of buildings (at 5 per cent) [1]	316,272,576	49.72
	Maintenance of implements and machinery (20 per cent)	253,029,956	39.78
	Taxes (0.6 per cent)	245,948,694	38.66
	Total	1,881,584,911	295.78
	Miscellaneous expenses (15 per cent of other expenses)	282,237,736	44.37
	Total expenses	2,163,822,647	340.15

SUMMARY.

Total gross income	$6,237,850,146	$980.55
Total expenses	2,163,822,647	340.15
Net farm income	4,074,027,499	640.40
Interest on investment (at 5 per cent)	2,049,572,454	322.18
Labor income [2]	2,024,455,045	318.22
Interest on mortgage ($1,715 at 6 per cent)		102.90
Available for purchase of live stock and for family living		537.50

[1] 4½ per cent in New England, New York, Pennsylvania, Michigan, and Wisconsin; 5 per cent in Virginia, West Virginia, Illinois, Missouri, Kansas, Iowa, Nebraska, Minnesota, North Dakota, South Dakota, Ohio, and Indiana; 5½ per cent elsewhere.

[2] Includes unpaid family labor and all the farm furnishes toward the family living except milk and cream. Does not include income from outside sources, and the amount paid for live stock bought must be deducted from this sum.

The items of income about which no information is available are the value of the milk and cream consumed on the home farm and what the farmer earns for work outside his farm. In some regions this latter item is important. Thousands of farmers receive a large part of their income from labor done for others at times when they do not have profitable employment on their own farms. In other sections of the country this item is unimportant.

The item of expenditure about which no information is obtainable is the amount paid for the live stock purchased. This is a very important item in those sections of the country where the fattening of stock is practiced. It is also a considerable sum in dairy regions, but in regions where no live stock except work animals and a few head of miscellaneous stock are kept it is not very important.

It is probable that the average working life of a horse is from 8 to 10 years. The average depreciation on work horses would then be from about 12 per cent to 10 per cent annually. Where work horses are the only animals kept, the expenditures for the purchase of live stock would therefore probably not average more than $15 or $20 per year per animal. It is impossible to give even a rough estimate of their cost in regions where live stock represent an important farm enterprise. The data presented in the accompanying table should be interpreted in the light of these omissions.

THE AVERAGE FARM INVESTMENT.

The average area of the American farm in 1910 was 138.1 acres. Of this area 75.2 acres are classed as improved land. The average area devoted to crops is 49.77 acres. The total average investment per farm is $6,443.67, the amount in farm buildings being $994.33 and that in implements and machinery, $198.88.

RECEIPTS.

The data for the receipts of the farmer are obtained entirely from the census returns. In this calculation the farm is credited with the total value of dairy products, wool, mohair, eggs and poultry, honey and wax, and domestic animals sold and slaughtered, with the exception of the milk and cream consumed on the farm where it is produced. This latter item is not given in the census returns. Whatever its value it should be added to the farm income.

The farm is also credited in Table I with the total value of all the crops produced except that part fed to live stock. This valuation is arrived at in the following manner:

The amount of corn, oats, barley, hay, and forage sold is deducted from the total value of these crops, it being assumed that the remainder is fed on the place and accounted for in the live-stock product listed earlier in the table. The value of that portion of these crops which is fed to live stock is then deducted from the total value of all the crops, the remainder being credited to the farm. The farm is thus credited with the butter, cheese, eggs, poultry, honey, meat, fruits, vegetables, bread, etc., consumed on the farm where it is produced, and the value of these products thus consumed on the farm is included in the farm income.

As stated already, any income the farmer may secure by work done outside his farm or from any other outside source is to be added to the net income given in Table I.

EXPENSES.

The only important item of expense not enumerated in the table is the sum expended annually in the purchase of live stock. Of the other expense items the amount for labor, fertilizers, and feed are given directly in the census returns.

The expense for the maintenance of buildings is placed at 5 per cent of the value of the buildings. This is only an estimate, but it is based on rather extensive investigations by the Office of Farm Management and is believed to be approximately correct.

The cost of maintenance, including repairs, of implements and machinery is placed at 20 per cent of their cash value. This estimate is based on extensive investigations by the Office of Farm

Management and agrees with the estimate in Warren's Farm Management. Taxes are assumed to be six-tenths of 1 per cent as an average for the whole country. This item will, of course, vary in different sections.

There are numerous other items of expense in the conduct of a farm. In a number of farm-management surveys conducted by the Office of Farm Management these remaining items have amounted on the average to about 15 per cent of other expenditures, and this is the factor assumed in the calculations here made. The total farm expenses, omitting the item of live stock purchased, are $340.15.

THE FARM INCOME.

The farm income is obtained by deducting the total expenses from the total receipts, and amounts to $640.40. If we assume 5 per cent as the rate of interest to which capital invested in agriculture is entitled, the farm income would then be distributed between interest and labor income as follows: Interest on investment, $322.18, labor income, $318.22.

Out of the farm income as here calculated, increased by outside earnings and by the value of milk and cream consumed on the home farm, the farmer must pay interest on his indebtedness, pay for any live stock purchased, and provide the living expenses of himself and family. The average farm mortgage in this country, based on the number of all farms, is $1,715, which at 6 per cent per annum amounts to $102.90. This amount deducted from the farm income of $640.40 leaves $537.50 (to which must be added the value of milk and cream consumed on the home farm and any income from outside sources) as the sum to be used in the purchase of live stock, in living expenses, and in savings.

In comparing the farmer's income with that of wage workers in any other industry it must be remembered that a majority of farmers are also capitalists. The interest on the farmer's capital thus constitutes a portion of this income, and this interest added to the small additional labor income he receives represents the sum available for his living. The labor income is undoubtedly smaller than it otherwise would be if the farmer did not also have the interest on his capital. Thus, we have found that in the better agricultural sections the labor income of tenants is considerably higher than that of farmers who work their own farms, although the latter have larger incomes than the tenants when we take into account the interest on their investment.

A very large percentage of American farmers live on the interest of their investment and do not receive anything for their own wages. Where the farm is of considerable size, such farmers are able to live

well, but on the small farm the interest on the investment is not sufficient to permit a high standard of living, so that the farmer must have some labor income in addition. The average income of the farmer could be increased by making the farms larger and thus reducing the number of individuals engaged in agricultural production. This could easily be done without decreasing production by better farm organization and the utilization of larger machinery and more power on the farm.

An average in itself has little meaning. In the present case, however, it is reasonable to infer that at least half of the farm families in this country have incomes smaller than those given in Table I. Individual farmers here and there have incomes larger than this average, but the facts presented in the table indicate that on the whole the income of farmers in this country, even when we include as a part of the income those things consumed on the farm where they are produced, is certainly not more than sufficient to pay 5 per cent on the investment and ordinary farm wages for the labor they do, and it is probably considerably less than this.

[Cir. 132—B]

COTTON FARMING IN THE SOUTHWEST.[1]

By O. F. Cook, *Bionomist in Charge of Crop Acclimatization and Adaptation Investigations.*

INTRODUCTION.

A new cotton industry is developing in the Southwestern States. Instead of extending, as formerly supposed, only to the middle of Texas, cotton culture now seems likely to become one of the chief agricultural resources of the whole region from the Rio Grande Valley in southern Texas through New Mexico and Arizona to the Imperial Valley of southern California.

The extension of cotton culture into the drier regions of the Southwest may be ascribed partly to the invasion of the former cotton belt by the boll weevil and partly to the fact that the southwestern conditions are really favorable for cotton culture. The drier climate not only affords protection against the boll weevil but against other dangers encountered in the Gulf States and along the Atlantic seaboard. The wilt and anthracnose diseases are often serious, and there are other insect enemies, such as the bollworm, the leaf worm, and the red spider, which sometimes destroy the crop quite as effectively as the boll weevil.

Another important consideration is that the harvest season in the Southwest is very long and usually quite rainless, so that the crop can be gathered without loss or injury from discoloration. Wet weather during the harvest season damages the eastern cotton crop every year to the extent of many millions of dollars. Little account is taken of such losses, because they are too frequent and familiar and are considered as ordinary accidents of farming.

It is no longer feared that the boll weevil will put an end to cotton culture in the Gulf and South Atlantic States, but the danger of weevil injury adds another element of uncertainty, so that the farmer can not rely upon cotton to any such extent as in the past. Other crops must be grown, and where these prove more profitable the planting of cotton is likely to decline or to cease altogether. Even in advance of the arrival of the boll weevil, cotton is losing ground in some districts because of other factors that render the crop uncertain.

[1] Issued July 19, 1913.

While the production of cotton may not decline in the more eastern States to the same extent that it has in Louisiana, there is certainly no reason to expect any such increase of production as will be necessary to enable the United States to supply its usual quota of the world's ever-increasing demand. It is therefore a matter of special interest at the present time that a new cotton industry can be developed in the Southwest, in a region whose agricultural possibilities are still only slightly appreciated.

The agricultural occupation of the Southwest is only beginning, and many years are likely to elapse before its resources of cotton production can be realized. Farming is attended by unusual difficulties because the conditions are so unlike those of other parts of the United States. The environment is a new one, not only for the cotton plant but for the farmer, and a period of adaptation is necessary for both. The plant has received more attention thus far than the farmer, and it is this inequality that must now be removed if substantial progress is to be made. The possibilities of cotton culture mean nothing without a farming population to take advantage of them.

The most striking advantages of irrigation agriculture are to be expected in the Southwest because of the climatic conditions that enable crops to be grown through the whole 12 months of the year. But it is these same climatic conditions that render the agricultural problems of the Southwest so new and difficult. The wider range of temperature prevents any direct duplication of the results that have been secured from fruit farming in some parts of California, where the development of irrigation facilities has been followed by an immense increase in land values. Different crops and different methods of farming must be used if any similar success is to be obtained in the dry, interior regions. Cotton is one of these crops that can not be grown near the coast, but requires the warmer climate of the dry interior to bring it to normal maturity.

COTTON AS A FACTOR OF AGRICULTURAL DEVELOPMENT.

The progress of the southwestern region as a whole must depend obviously on the establishment of a series of agricultural industries, of which cotton seems likely to be one of the most important and one of the easiest to develop. Indeed, it is hardly too much to say that for many of the more isolated southwestern communities cotton now appears to be the only staple commercial crop that can be raised with a fair prospect of a remunerative cash return. And even in communities where transportation facilities exist, so that fruits or other perishable products can be sent to market, cotton is likely to become popular as one of the safest crops, if not the most profitable.

In southern Texas, as well as in Arizona and California, irrigation facilities have been provided largely with a view to other crops that have been considered more profitable than cotton. The present indications are that cotton will be recognized eventually as the chief agricultural resource of many enterprises that have been promoted on the basis of more speculative truck and fruit crops. Such crops are much more likely to be established on a permanent basis by farmers who can assure themselves of an ordinary living from cotton or other staple products than by farmers entirely dependent on the sale of cantaloupes, onions, or other precarious specialties.

Yet it would be entirely unreasonable to expect that all of the present settlers in the Southwest will become successful cotton farmers. Many have not engaged in farming except as a speculation and in the hope of sudden wealth from bonanza crops. They have not adopted agriculture as a chosen occupation or as a life which they prefer. The intention may be merely to hold on until the community has passed through the pioneer period and then to sell their land at a price that will enable them to find a more congenial existence in town. Another element of the population comes to the Southwest in search of health rather than to undertake farming. Some of these health seekers have financial resources and are not obliged to make a living from the land on which they settled. It seems very strange in some of these southwestern settlements to find so few able-bodied men on the land. But it often happens that men who come to the Southwest as invalids are brought to study the problem of adapting themselves to the country more carefully than their neighbors and become especially useful citizens. In view of the nature of the resident population it may be reckoned as one of the advantages of cotton that it can employ the labor of those who are not strong enough for other kinds of farm work.

Compared with most of the crops that have been proposed for the Southwest, cotton affords a surer return with a smaller demand of heavy labor. The chief difficulty and expense in raising cotton lie in the picking, but the labor is not severe or exacting as to the time when it must be done. As a family crop for people who do their own work and have some assistance from their wives and children, cotton could hardly be excelled. The harvest season extends over three or four months, or even longer, so that much spare time can be used to advantage in picking cotton. The planting of cotton as a supplementary crop or for the small farmer is limited, of course, to districts where ginning facilities exist, but in all such communities cotton may be expected to contribute a large share to the local prosperity.

The development of cotton culture may be expected to stimulate the growth of many other industries in the Southwest, both agricultural and commercial. The most serious handicap of the cotton

industry at the present time is the scarcity and high price of labor, but the completion of the Panama Canal is expected to increase the labor supply by direct immigration from Europe. Another possibility of the future is the establishment of cotton mills in Los Angeles or other cities of southern California, where enormous supplies of electric power are soon to be available, as well as increased facilities for irrigation. This combination of power and water in the mild climate of southern California may be expected to stimulate a rapid development of manufactures, because the laboring population will be able to reduce living expenses and supplement its earnings by garden products that can be grown throughout the year. Thus, the development of a local market for the southwestern cotton crop can no longer be considered improbable.

SPECIAL REQUIREMENTS OF COTTON CULTURE IN THE SOUTHWEST.

To meet the present high cost of labor and transportation it is necessary to produce cotton that can be sold at higher prices than the ordinary short-staple cotton raised in the older parts of the cotton belt. Experiments have shown conclusively that cotton of high quality, both Egyptian and long-staple Upland, can be raised on the irrigated lands of the Southwest, but at the same time it has become apparent that the methods of farming now followed in most of the southwestern communities are too desultory and unskillful to warrant a hope of realizing the full possibilities of cotton culture. The Salt River Valley of central Arizona is the only district now ready to undertake the production of Egyptian cotton on a commercial scale. In the Imperial Valley of southern California several thousand acres are planted with Durango cotton, a new long-staple Upland type, recently acclimatized from Mexico.

Highly specialized systems of cotton culture are not likely to be developed or maintained in communities where the people are too careless or too little interested to learn how to live and work under the new conditions in which they have placed themselves. It is true that many of the present landholders of the Southwest do not think of themselves as permanent settlers, but expect to make their profits from the sale of their property rather than from raising crops. But even from the standpoint of real-estate values it is highly desirable that the agricultural possibilities of the region be developed.

To take any full advantage of the favorable southwestern conditions, long-staple cottons, either Egyptian or Upland, must be grown, which means that more skillful farming is required than for the production of short staples. This is not because the long-staple varieties are more difficult to raise but because of the higher requirements

of uniformity in long-staple cottons. To secure uniformity two kinds of precautions are necessary. The seed that is planted must come from a uniform stock, and the plants must be grown under uniform conditions. The latter requirement is more easily met, of course, where water can be supplied by irrigation than where the crop is dependent upon rain, but successful irrigation farming requires special knowledge and skill to understand the requirements of the crop and to apply water to the best advantage. There is a very general tendency in irrigated districts to use too much water and to neglect other cultural requirements. The result is that there is usually a very wide discrepancy between the actual results of irrigation farming and those that are sometimes obtained when better methods are used.

COTTON, A HOT-WEATHER CROP.

Cotton is a summer crop and has to be cared for through the hottest months of the year. This fact gives a direct agricultural bearing to the question of how the farmers who are to raise the cotton are to live through the heated term. Though the high temperatures are not as uncomfortable in the dry climate of the Southwest as people from humid climates expect, the summer season involves a strain that some are unable to withstand. The utilization of cotton or any similar crop is likely to depend very largely on the ability of the farmer and his family not merely to exist and preserve a land title through the summer but to live in a normal manner, so that the necessary attention to crops can be given. It is quite as necessary that the farmer learn how to adapt himself to climatic conditions as to plant the right crops or to care for them in the right way.

If it is not possible for the farmer to live and work through the summer without too much hardship or danger to the health of himself and his family, the raising of cotton can not be advised, or even the occupation of the land by people who are to depend on such crops for a living. Questions of housing, rest, and food for the farmer and his family are of agricultural importance no less than the needs of the animals and plants that are raised on the farm. Even the animals have to be spared from labor and protected from overheating when the weather gets too hot. In the eastern part of the cotton belt efforts are being made to induce the farmer to give better housing to his cotton bales, instead of leaving them out to be damaged by wet weather. But in the Southwest it is the farmer and his family who need better housing to afford protection against the hot weather that otherwise interferes too much with agricultural activity.

The use of the farmer's personal resources of health and strength needs to be considered, as well as the results of different expenditures

of time and money that receive such careful determination in the interest of agricultural improvement. That a farmer may have the physical strength to work through the southwestern summer does not prove that it is good policy for him to use his energies in this way in merely resisting exposure to adverse conditions which could be avoided in other ways. Men who are living near the margin of physical endurance are not in condition to use the intelligent care and discrimination that are needed to handle their crops to the best advantage or to undertake such work as the selection and roguing of seed fields, which are among the necessities of successful cotton culture.

It is true that most of the heavy labor of cotton culture, the plowing, planting, and cultivation, is done in the spring before the heated term begins, but the later cultivation, thinning, and roguing may need to be attended to in hot weather, when irrigation becomes especially important. The crop must have the attention that it needs, as well as the labor. Indeed, the labor may easily fail of the proper result if other precautions are neglected, and the danger of neglect is greatest in hot weather.

THE AGRICULTURAL IMPORTANCE OF THICK-WALLED HOUSES.

Even the simplest precaution of securing protection against heat by using thick-walled houses has been almost entirely neglected. The fact that the winters are not severe has been taken to mean that light, thin-walled wooden structures are sufficient, as they are in the equable climate of the coast of California. In this, as in many other respects, the experience of other hot, dry regions of the world has been almost completely ignored in the Southwest. Buildings with thick walls, either of masonry or adobe, are found in some of the towns that date back to the period of Spanish or Mexican colonization, but the value of such buildings as a means of protection against extreme heat seems to have been left out of account almost entirely in the settlements that have been made in recent decades. It does not occur to a progressive American farmer to imitate his more backward Mexican neighbors or to suppose that the Mexican methods of building can be superior in any way to his own.

The chief value of thick-walled houses in warm climates is that they enable rest to be taken in the middle of the day when it is too hot to work. With the temperature above 100° F., refreshing sleep or other forms of rest or recreation become impossible. It is easy to fall into a feverish stupor which leaves one dazed and relaxed, and often with a headache that continues for the remainder of the day. When the air is heated to these extreme temperatures one suffers no more out in the sun, where the perspiration evaporates more rapidly and keeps the skin cooler. Men who are able to work through

the day in the field find it less uncomfortable than to stay in overheated houses. But even this relief is not for the women and children.

In a house with thick walls it is possible to have rooms that remain comparatively cool during the hot hours of the day. Inner rooms with masonry or concrete floors in contact with the earth, or carried down below the surface, may remain as much as 20 degrees cooler than the outside air. This difference of temperature and the relief from the strong light are conducive to prompt and refreshing sleep. Under such circumstances sleeping in the middle of the day is not to be condemned as a lazy habit or a waste of time, but is a reasonable means of preserving bodily strength and mental activity.

The practical advantage of being able to secure normal sleep in the middle of the day is that work may begin earlier in the morning. The best hours of the day in which field work can be done most comfortably and efficiently are those between 4 and 7 o'clock a. m., hours which nearly all of our southwestern settlers spend in sleeping or eating breakfast. If these hours could be added to the usual forenoon's work more could often be accomplished than in a whole day on the present system. Or if working from 4 o'clock to 11 were not deemed sufficient it would still be possible to add three or four hours more in the afternoon, after sleeping two or three hours in the hottest part of the day. But without provision for normal sleep in the middle of the day the early morning hours must be used for this purpose. Going to bed early in the evening is not a practical alternative, for it may not be cool enough for normal sleep until nearly midnight. Thick-walled houses are also hot in the evening, but ideal sleeping accommodations are afforded by the roofs, in accord with the custom of Bible times still in use in oriental countries.

SUMMER FOOD CROPS TO ACCOMPANY COTTON.

The lack of summer food crops may be taken as another evidence that the problems of agricultural existence in the Southwest have not received attention. Though all the supposed requirements of plant growth, heat, light, and moisture are at hand, the farmer often finds himself with nothing that will afford a wholesome diet during the heated term, and in a land of potential plenty must fall back upon canned goods, with a few high-priced vegetables brought in from the coast.

When proper food is lacking, the difficulties of working through the summer, or even of withstanding the heat, are greatly increased. And when food and shelter alike are deficient or of the wrong kind it is no wonder that even the most active pioneer may lose some

of his enthusiasm before the summer is over and conclude that his neighbors are not so far wrong in wishing to sell out and move back East to the coast. Such defeats and disappointments are inevitable unless settlers can be warned in advance and understand that they must provide themselves with new agricultural weapons in the way of special crops and methods of growing them, if they are to overcome the difficulties and enter into permanent possession of the agricultural resources of the southwestern country.

The agricultural possibilities of the Southwest are only faintly suspected on the basis of the few crops now raised; likewise the possibilities of making existence enjoyable in places that now seem hopeless deserts. The present methods are not only inadequate, but are often actually destructive, as when the use of too much water brings up alkali that might otherwise lie harmless in the lower layers of the soil. Methods of extensive farming, proper enough in other parts of the United States, are being used, to the general neglect of the much more important possibilities of intensive farming. The idea that a family can live well and accumulate a competence on a small farm of 5 or 10 acres, as so often stated in prospectuses of irrigated lands, is not to be realized without radical changes of methods. Even the present system of sending supplies of irrigation water through earth canals, at intervals of a week or longer, may prove inadequate for the desired results. Cement channels to afford continued supplies of water may prove economical in the end in spite of their great initial cost. There is an immense waste of water as well as of land in the present system of earth ditches. These are not engineering questions alone, but must be considered ultimately from the standpoint of the farmer and his crops. There can not be farmers without crops or crops without farmers.

Perhaps the best way to think of the possibilities of agricultural development is to remember that an irrigated district in a desert is an oasis and that the plants that have thriven in the Southwest, the cotton, alfalfa, date palms, olives, pomegranates, etc., are those that have come from other dry countries where irrigation is practiced, in Africa and Asia, instead of from other parts of the United States or from Europe. Many other crops, and especially food plants, that are raised under irrigation in other countries have yet to be established in the Southwest.

A further consideration is that many of the oasis food crops are not raised by the methods now used in the Southwest, where it is customary to plant everything out in the sun, but as subcultures, that is, under the partial shade of date palms or other trees, so that the exposure to heat and light is somewhat reduced. The subculture

system, which is also used with many tropical crops, might be described as the reverse of the dry-farming system. The object is not to get the plants farther apart, so that they can draw for water upon a larger area of ground, but to protect them against excessive transpiration by keeping them closer together. Under irrigated conditions the water supply is no longer the limiting factor of plant growth, but the excessive transpiration that results from exposure to the sun. That any crops will grow better under the shade of trees than out in the open ground seems a very absurd idea to the eastern farmer, but such facts are very likely to have practical importance in the agricultural development of the Southwest and experiments along many new lines will be needed before it can be said that the agricultural possibilities of this region have been determined.

CONCLUSIONS.

A new cotton industry is coming into existence in the Southwestern States. The dry climate affords protection against the boll weevil and many other insect enemies and diseases that often reduce or destroy the cotton crop in the East. The absence of wet weather in the harvest season also allows the western cotton to be gathered and sent to market in better condition. These are important advantages and go far toward counteracting the higher cost of labor and transportation. But the agricultural development of the Southwest is attended by several difficulties that must be surmounted before any very extensive utilization of the natural resources of cotton production can be expected.

The agricultural possibilities of the region are not yet appreciated, and the agricultural population is still very small. Many of the present settlers have not come to engage in farming as a permanent occupation, but are in search of health or of profits to be realized by a rapid increase of the value of real estate on the irrigation projects. The presence of this temporary population, not adapted to agricultural work or definitely interested in agricultural problems, makes it more difficult to secure an effective community development of cotton culture or other specialized industries. Cotton of high quality must be grown if the crop is to be profitable, and this requires the presence of an intelligent, efficient agricultural population.

Another obstacle to the progress of cotton culture in the Southwest lies in the fact that the present methods of living and work are not well adapted to the climate. Many of the settlers are unable to work or to stay on their farms during the extreme heat of the summer, and those who remain subject themselves and their families to a test of endurance that often ends in disaster and discouragement.

In the interest of agricultural progress, as well as for other reasons, these conditions must be improved. A better system of house construction is needed to give shelter from high temperatures and make it possible to sleep or rest in the middle of the day and utilize the cooler hours of the early morning for field work.

The health and efficiency of the farming population are also likely to depend to a considerable extent upon the introduction and use of new plants able to grow through the summer in spite of the extreme conditions that are fatal to most of the food plants, fruits, and ornamentals raised in other parts of the country. The irrigated districts of the Southwest are in reality new oases in the desert, and their possibilities of development should be investigated from this point of view. To settlers from other parts of the United States, or even from Europe, the southwestern conditions are altogether new, and we need to profit by the methods and the crops that have been developed in other desert countries to a much greater extent than has appeared thus far.

MOSAIC COHERENCE OF CHARACTERS IN SEEDS OF MAIZE.[1]

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In the progeny of crosses between individuals that differ in a number of characters there is often a tendency for the original combinations of characters to remain together instead of being distributed indiscriminately. This tendency for groups of characters represented in the parents to reappear has been recognized as a factor of heredity and is called "coherence." Hybrids between Egyptian and Upland cotton afford a good example of the coherence of characters. The corolla of Egyptian cotton is tubular in form and yellow in color. The flowers of Upland varieties are white and have a more open, cuplike form. Among hybrids between these two types yellow-flowered plants almost invariably have the flowers tubular and show other Egyptian characters. Yellow flowers that are spreading or white flowers that are tubular are of very rare occurrence.[2] There is thus said to be a coherence between the color and form of the corolla and in this instance the coherence is nearly perfect.

Coherence of characters has usually to be determined by statistical methods, it being necessary to examine a large number of hybrid individuals to determine whether certain combinations occur more frequently than the laws of chance would indicate. In hybrids between Chinese maize with waxy endosperm and our common varieties with horny endosperm there is a definite tendency for the particular combinations of endosperm texture and aleurone color that existed in the parents to persist and reappear in a relatively large percentage of the progeny. This partial coherence of characters has been found without exception in the progeny of the 100 or more crosses that have been examined.

To demonstrate a coherence of this nature it is necessary to separate the seeds into the two classes, colored and white. If there is found to be a significant difference between the percentage of waxy seeds in the two groups there is a correlation. If the largest percentage of waxy seeds is found in the group having the same aleurone color as the waxy parent the correlation is a coherence.

[1] Issued July 19, 1913.

[2] Cook, O. F. Suppressed and intensified characters in cotton hybrids. U. S. Department of Agriculture, Bureau of Plant Industry, Bulletin 147, p. 17, 1909.

While these numerical relations adequately demonstrate the reality of the phenomenon, it is not without interest to find cases in which the tendency to coherence is manifested in another and more direct way.

Aleurone color, while in general alternative in its inheritance, often appears in the form of a mosaic, the colored spots varying from almost the entire surface of the seed to the contents of a single cell. The texture of the endosperm is more uniform in its behavior, mosaic inheritance being very rare. In classifying upward of 100,000 seeds only 8 have been observed in which the texture of the endosperm was not uniform throughout the seed. In two of these seeds which showed a mosaic endosperm the aleurone color also appeared in spots and in both of these seeds the mottling of the two characters coincided.

The fact that the spots of aleurone color and the segments of a different endosperm texture corresponded was first noticed by Mr. O. F. Cook in a seed from an ear (Dh359) that resulted from pollinating a plant of the Chinese variety having waxy endosperm and colored aleurone with pollen from a white variety having the ordinary horny endosperm. The aleurone color of the Chinese variety is almost completely recessive to the white of the Gracillima variety with which it was here crossed, and the majority of the seeds were without color. The remainder showed aleurone color in spots of varying size. With the exception of the single seed in question all the seeds of Dh359 were horny, waxy endosperm, being recessive to all other forms of endosperm. In this one seed there was a small waxy area directly beneath a spot of aleurone color and corresponding to it in shape.

The coincidence of the boundaries of the colored spot and waxy area are so exact that the idea of the superposition being the result of chance can not be entertained.

The second example of mosaic coherence occurred in the second generation of Dh209, a cross between a white waxy strain of Chinese and a colored sweet variety.[1] In one of the seeds of this ear the endosperm was waxy except a portion comprising about one-fourth of the seed, which was horny. The waxy portion was overlaid by a white or colorless aleurone, while the aleurone over the horny portion of the endosperm was a deep purple.

In both of these mosaic seeds it will be noted that the association of characters is the same as in the parental strains. Thus, in the first example the Chinese parent having the waxy endosperm had a colored aleurone and in the mosaic seed the waxy portion is overlaid

[1] For a discussion of these hybrids, see Collins, G. N., and Kempton, J. H., Inheritance of waxy endosperm in hybrids with sweet corn, U. S. Department of Agriculture, Bureau of Plant Industry, Circular 120, pp. 21–27, 1913.

by a colored aleurone. In the second example, the waxy parent was white and in the mosaic seed from this cross the waxy portion of the seed is white. In both seeds the form of the colored spot is irregular and the line separating the two kinds of endosperm follows the irregular margin of the spot with great precision.

In the second example, Dh209, the tendency for the white and waxy characters to be associated is also shown in the usual way by the relative numbers of seeds in the different classes. The ear had 561 seeds. Aside from the mosaic seeds these were readily separated into six perfectly distinct classes, as follows: Colored horny, 295; white horny, 42; colored sweet, 101; white sweet, 34; colored waxy, 35; white waxy, 53. Considering the entire ear, 23 per cent of the seeds are white, but of the 88 waxy seeds 60.2 per cent are white.

It might be urged that the correlation shown in the mosaic seeds is physiological. There may be some physiological or chemical reason why a colored aleurone conduces to the development of a waxy texture in the endosperm immediately beneath it, or the waxy endosperm might react on the aleurone immediately above it in a way to produce color. But the fact that the coherence is between colored aleurone and waxy endosperm in one example and between colored aleurone and horny endosperm in the other renders any strictly chemical explanation inadequate.

The Mendelian conception of coherence or gametic coupling is that attractions or repulsions exist between character determinants, causing certain combinations in the gametes to occur more frequently than others. This explanation can not be applied to examples of mosaic coherence, since in the case that represents the first-generation hybrid (Dh359) the segregation has not yet taken place. If we are to venture into this dangerous field of speculation it seems more reasonable to think of the parental gametes as being imperfectly combined, the two parts of the seed falling under the influence of different parents.

Whatever may prove to be the cytological explanation, these mosaic seeds make the phenomenon of coherence appear more tangible and direct by affording a visible example.

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